# UM1936
# User manual

## Getting started with osxMotionAR activity recognition library for X-CUBE-MEMS1 expansion for STM32Cube

## Introduction

This document describes how get started with the osxMotionAR software package.

The osxMotionAR activity recognition algorithm is provided in static library format and is designed for use in combination with the NUCLEO-F401RE (STM32 Nucleo development board) and X-NUCLEO-IKS01A1 (motion MEMS and environmental sensor expansion board) or X-NUCLEO-IKS01A1 plus STEVAL-MKI160V1 (LSM6DS3 adapter board for standard DIL24 socket). The osxMotionAR library is integrated in a software package providing implementation examples for the above platforms.

The software is based on STM32Cube technology. Information about STM32Cube is available on www.st.com at *http://www.st.com/stm32cube*.

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# 1 osxMotionAR library add-on to X-CUBE-MEMS1 software expansion for STM32Cube

## 1.1 osxMotionAR overview

The osxMotionAR library is a complete middleware solution aimed at building applications strictly for 3D accelerometer sensors.

The software runs on the STM32 microcontroller and includes drivers to recognize the available inertial sensors (currently LSM6DS0 or LSM6DS3).

It provides real-time information on the following activities performed by the user:

- stationary
- walking
- fast walking
- jogging
- biking
- driving

It is built on the STM32Cube software platform to facilitate portability across different STM32 microcontrollers.

The key package features include:

- complete middleware to build applications specifically for LSM6DS0 or LSM6DS3 motion sensor accelerometer sections;
- osxMotionAR activity recognition middleware (under open.MEMS license)
- easy portability across different MCU families, thanks to STM32Cube
- sample applications to transmit activity data to a PC
- sample implementations available for the X-NUCLEO-IKS01A1 board (optionally with the LSM6DS3 adapter board) when connected to NUCLEO-F401RE
- the software comes with driver implementation examples, running on NUCLEO-F401RE mounted with the X-NUCLEO-IKS01A1 expansion.

## 1.2 osxMotionAR architecture

The software is an expansion for the X-CUBE-MEMS1 software.

The package extends STM32Cube with a middleware component for the osxMotionAR library.

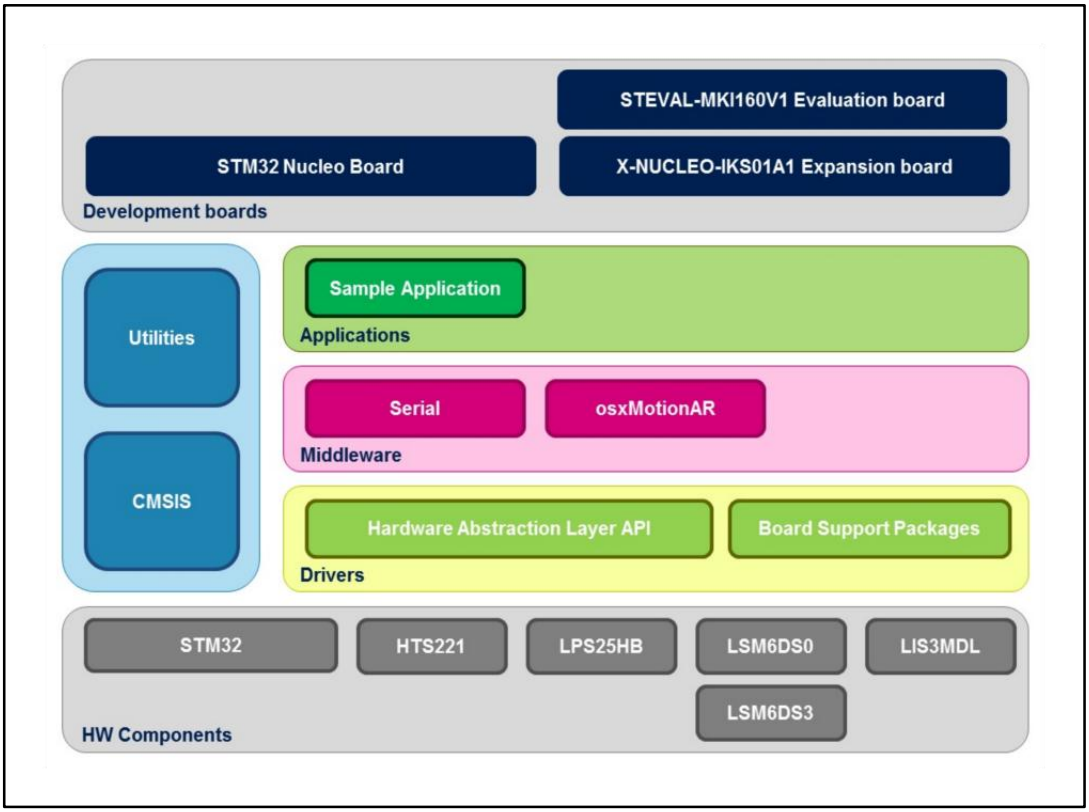
The following software layers are used by the application to access and use the sensor expansion board:

- STM32Cube HAL layer: the HAL driver layer provides a generic, multi-instance, simple set of APIs (application programming interfaces) to interact with the upper layers (application, libraries and stacks). It is composed of generic and extension APIs. It is directly built around a generic architecture and allows the layers that are built upon, such as middleware layers, to implement their functionalities avoiding dependencies on the specific hardware configuration for a given microcontroller unit (MCU). This structure improves library code reusability and guarantees easy portability to other devices.
- Board support package (BSP) layer: the software package needs to support all the available peripherals on the STM32 Nucleo board apart from the MCU. This software

is included in the board support package (BSP). This is a limited set of APIs which provides a programming interface for certain board specific peripherals; e.g., the LED, user button, etc. This interface also helps in identifying the specific board version. If the sensor expansion board is used, it provides the programming interface for various inertial and environmental sensors. It provides support for initializing and reading sensor data.

The diagram below outlines the software architecture of the package:

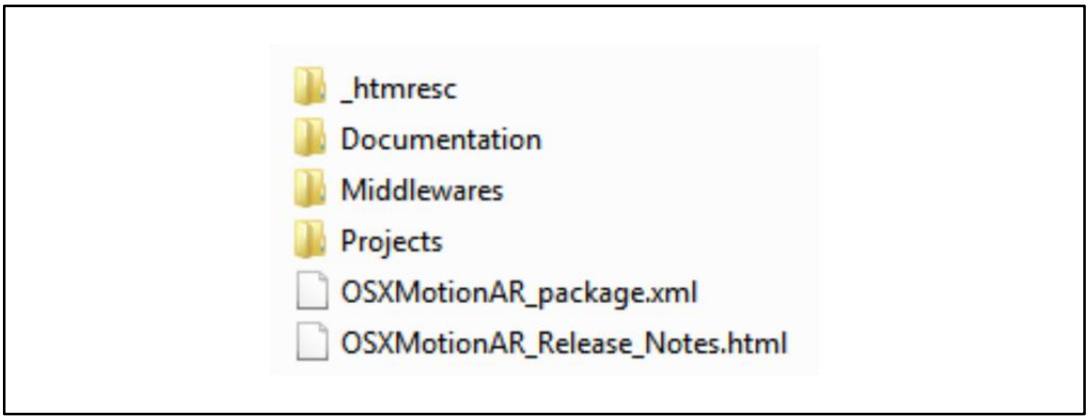
**Figure 1: osxMotionAR plus X-CUBE-MEMS1 software architecture**




## 1.3 osxMotionAR folder structure

The image below outlines the package file system architecture:

**Figure 2: osxMotionAR package folder structure**



The following folders are included in the package:

- **Documentation**: this folder contains a compiled HTML file generated from the source code and documenting in detail the software components and APIs (doxygen).
- **Middlewares**: this folder contains the osxMotionAR static library binary code, the library header file, documentation, license information plus header file for node-locked license validation.
- **Projects**: this folder contains a sample application used to access sensors and activity data, provided for the NUCLEO-F401RE platform according to three IDE (Integrated Development Environments) proprietary formats (IAR Embedded Workbench for ARM, µVision (MDK-ARM) toolchain, System Workbench for STM32).

## 1.4 osxMotionAR APIs

Detailed technical information fully describing the functions and parameters of the osxMotionAR APIs can be found in the OSXMotionAR_Package.chm compiled HTML file located in the Documentation folder of the software package.

The osxMotionAR is provided as a node-locked library which allows derivative firmware images to run on a specific STM32 Nucleo device only. Licensing activation codes must be requested from ST and included in the project (and become part of the build process) prior to attempting its usage. The resulting firmware binary image will therefore be node-locked.

For complete information about the open.MEMS license agreement, please refer to the license file located in the Middlewares/ST/STM32_OSX_MotionAR_Library folder.

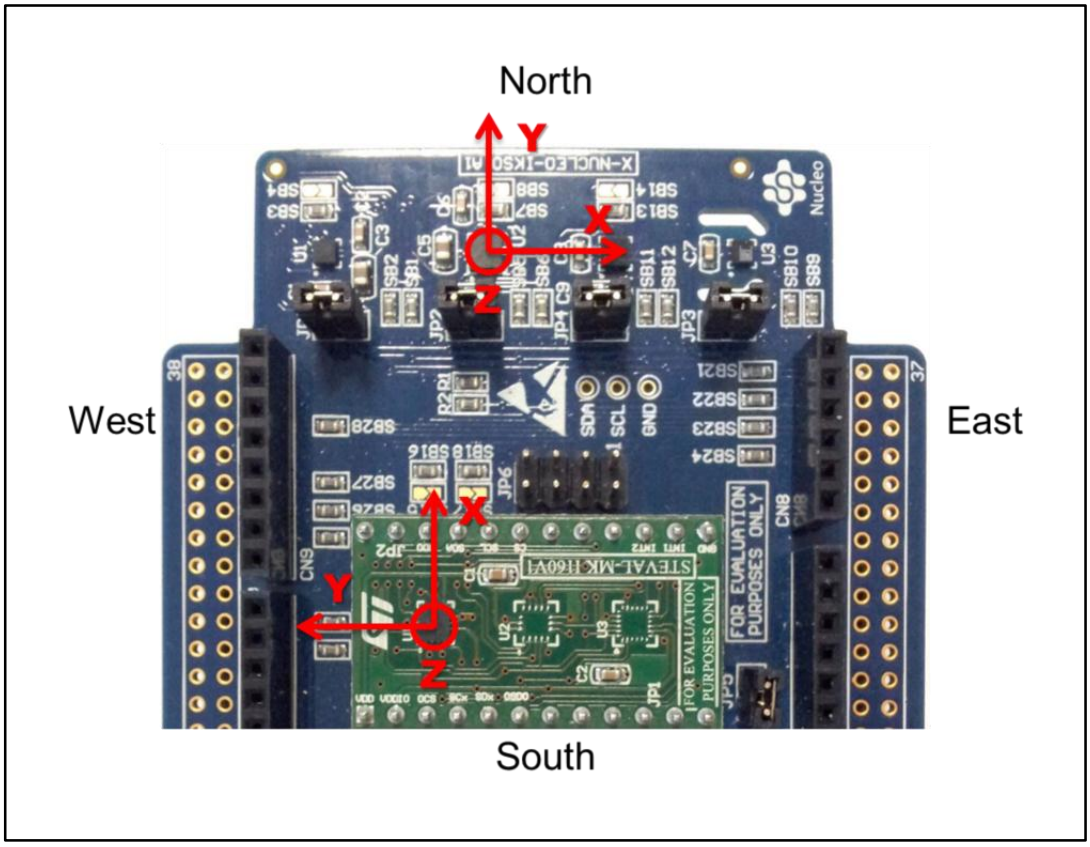
### 1.4.1 osxMotionAR library

The osxMotionAR is a real time activity recognition software solution. The algorithm only manages the data acquired from the accelerometer, at the low sampling frequency of 16 Hz to reduce host platform power consumption.

The exposed APIs of the osxMotionAR library are listed below:

- `uint8_t osx_MotionAR_GetLibVersion(char *version);`
  - retrieves the revision of the included core engine;
- `osx_lm_result_t osx_MotionAR_Initialize(void);`
  - performs osxMotionAR initialization and setup of the internal mechanism used for node-locking (See *Section 3.5.3: "osxMotionAR installer setup"*). The output for correct or incorrect initialization is OSX_SUCCESS or OSX_FAILED respectively (e.g., OSX_FAILED is returned for license errors);
- `void osx_MotionAR_SetOrientation_Acc const char *acc_orientation);`
  - this function is used to set the accelerometer data orientation; library configuration is usually performed immediately after the `osx_MotionAR_Initialize` function call.
    The required input is a pointer to a string of three characters indicating the direction of each of the positive orientations of the reference frame used for accelerometer data output, in the sequence x, y, z. Valid values are: n (north) or s (south), w (west) or e (east), u (up) or d (down).
    As shown in the figure below, the X-NUCLEO-IKS01A1 accelerometer sensor has an ENU orientation (x - East, y - North, z - Up), so the string is: “enu”, while the accelerometer sensor in STEVAL-MKI160V1 is NWU (x-North, y-West, z-Up): “nwu”.

**Figure 3: Example x, y, z axes values**




- `osxMAR_output osx_MotionAR_Update (osxMAR_input *data_in);`
  - The required input is a pointer to a structure containing the three axis accelerometer data expressed in [g]; the output is osxMAR_output, indicating the activity code and is an enum.

## 1.5 Sample application

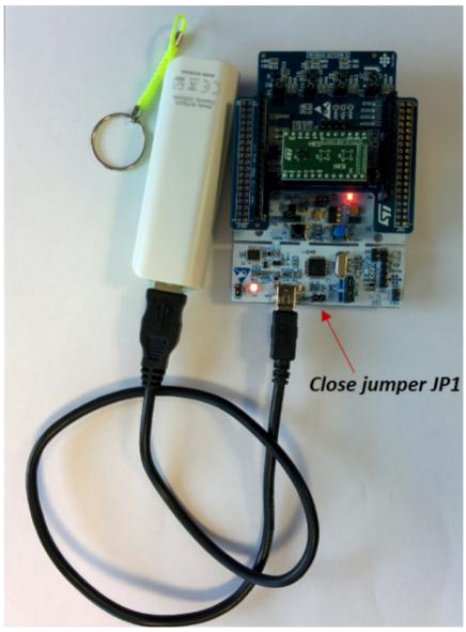
The osxMotionAR middleware can be easily manipulated to build user applications; an application example is provided in the *Projects* folder.

It is designed to run on a NUCLEO-F401RE board connected to an X-NUCLEO-IKS01A1 board (based on LSM6DS0), or a NUCLEO-F401RE board connected to an X-NUCLEO-IKS01A1 plus a STEVAL-MKI160V1 board (based on LSM6DS3).

The application recognizes the performed activities and stores them in the board memory for offline analysis. The algorithm recognizes stationary, walking, fast walking, jogging, bike riding and driving activities.

In normal activity acquisition mode, the STM32 Nucleo board may be supplied by a portable battery pack (*Figure 4: "STM32 Nucleo board connected to battery pack; jumper JP1 closed"*) to make the user experience more comfortable, portable and free of any PC connections.

**Figure 4: STM32 Nucleo board connected to battery pack; jumper JP1 closed**




A USB cable connection is required to transfer the acquired data from the MCU to a PC. Once connected, launch the dedicated *Sensors_DataLog* GUI and connect it to the STM32 Nucleo board; for more details, refer to *Section 1.5.2: "Sensors_DataLog utility"*.

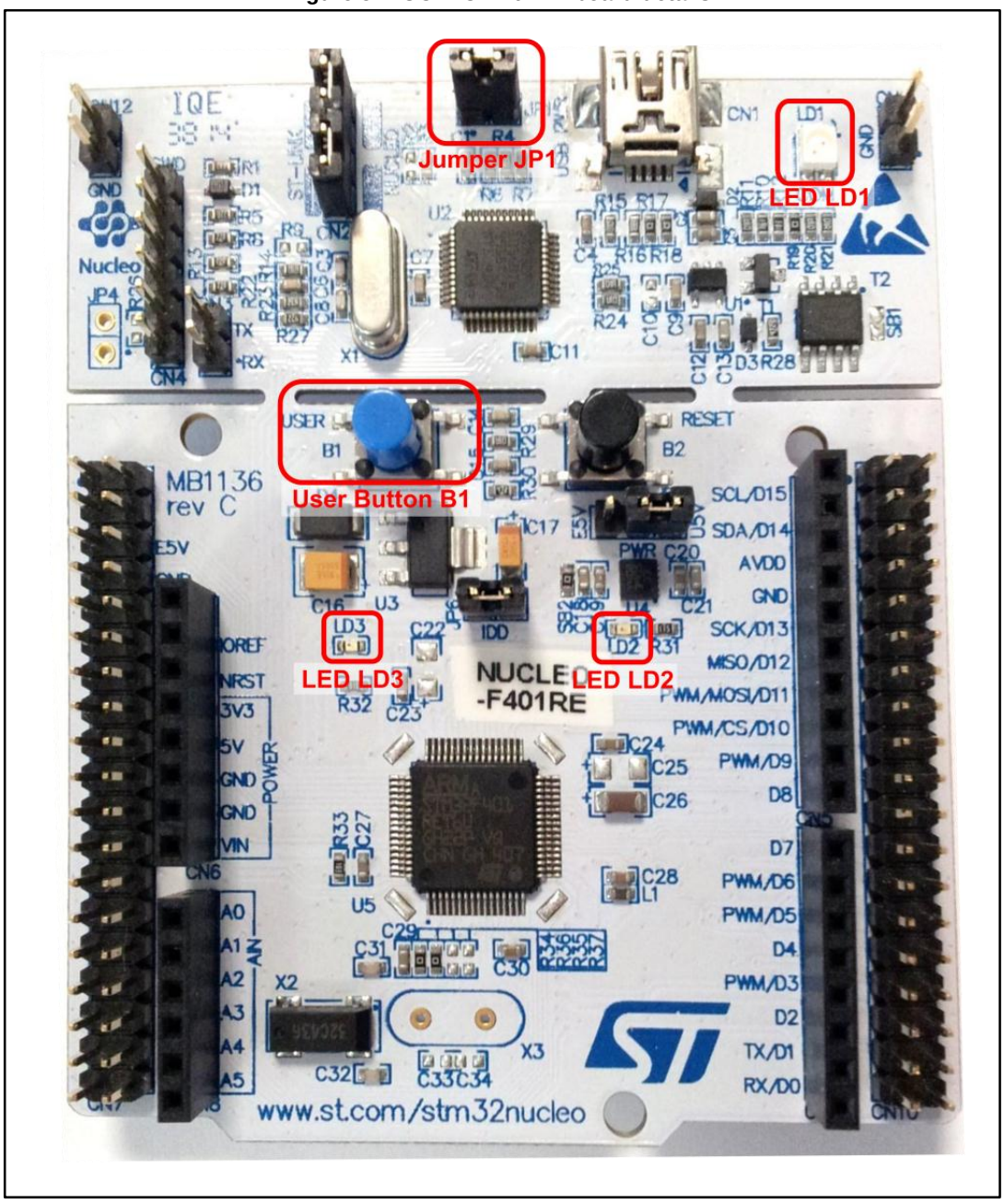
**Table 1: Power supply scheme**

| Power Source | NUCLEO-F401RE settings | Working Mode |
|---|---|---|
| USB PC cable | JP1 open | Data upload to PC |
| Battery pack | JP1 closed | Activity Acquisition (Normal) |

### 1.5.1 Activity acquisition working mode

In normal working mode, the user can power the board by means of an external battery pack (*Figure 4: "STM32 Nucleo board connected to battery pack; jumper JP1 closed"*), ensuring that jumper JP1 is fitted.

**Figure 5: NUCLEO-F401RE board details**




The above figure shows the user button B1 and the three LEDs of the NUCLEO-F401RE board. Once the board is powered, LED LD3 (PWR) turns ON and the tricolor LED LD1 (COM) begins blinking slowly due to the missing USB enumeration (refer to user manual UM1724 *STM32 Nucleo boards* for further details).

When user button B1 is first pressed and LED LD2 (USER) is OFF, the system starts acquiring data from the accelerometer sensor and detects the performed activity; during this acquisition mode, rapid LED LD2 blinking indicates that the algorithm is running.

Pressing button B1 a second time stops the algorithm (and the relative data storage session) and the LED LD2 displays the activity code according to a sequence of flashes described in *Table 2: "LED LD2 activity codes"*.

By pressing the button B1 a third time, the system goes in standby mode; i.e., the algorithm is not running and LED LD2 is off.

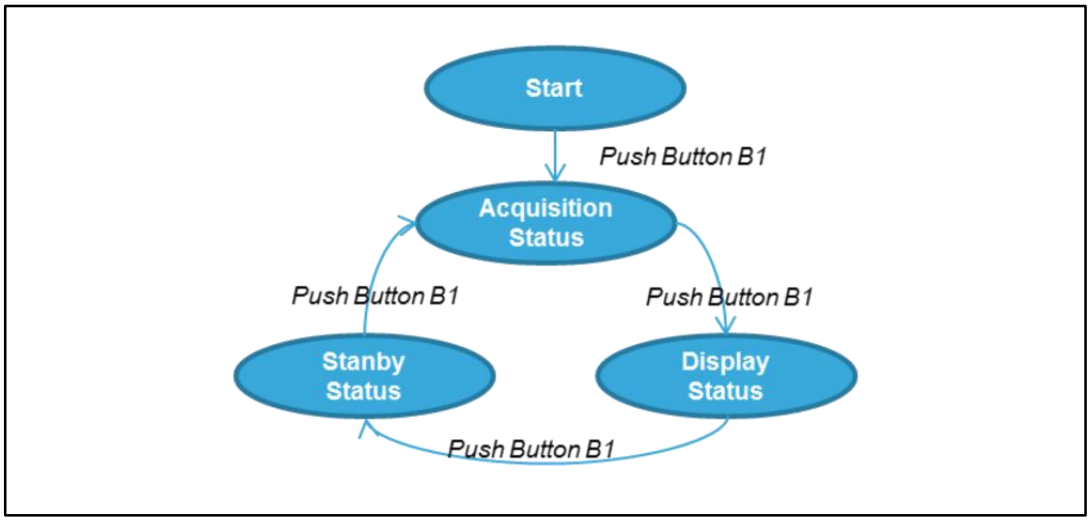
Pressing the button again initiates the algorithm and data storage once more (see *Figure 6: "State machine"*).

If the LED LD2 is ON after powering the board, this represents a warning message indicating that the flash memory is full or almost full (see *Section 1.5.3: "Data storage"*) or the library has an incorrect embedded license number.

**Table 2: LED LD2 activity codes**

| Activity | LED LD2 blinking sequence (5 s interval) |
|---|---|
| Stationary | 1 |
| Walking | 2 |
| Fast walking | 3 |
| Running | 4 |
| Biking | 5 |
| Driving | 6 |

**Figure 6: State machine**




## 1.5.2 Sensors_DataLog utility

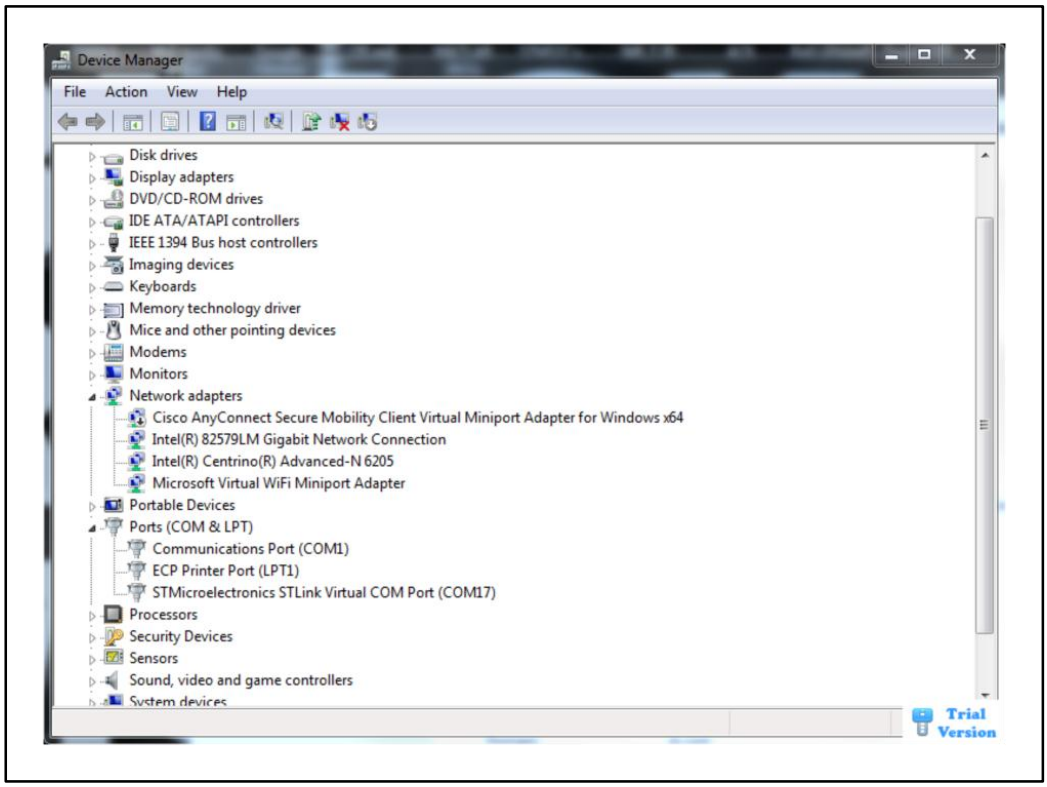
The osxMotionAR software package for STM32Cube uses the Windows *Sensors_DataLog* utility of the STM32CubeExpansion_MEMS1_ V1.3.0 package in the ROOT_DIR\Utilities\PC_software folder.

Before using it, ensure that the necessary drivers are installed and the expansion board and the STM32 Nucleo board is connected to the PC.

Please follow these steps:

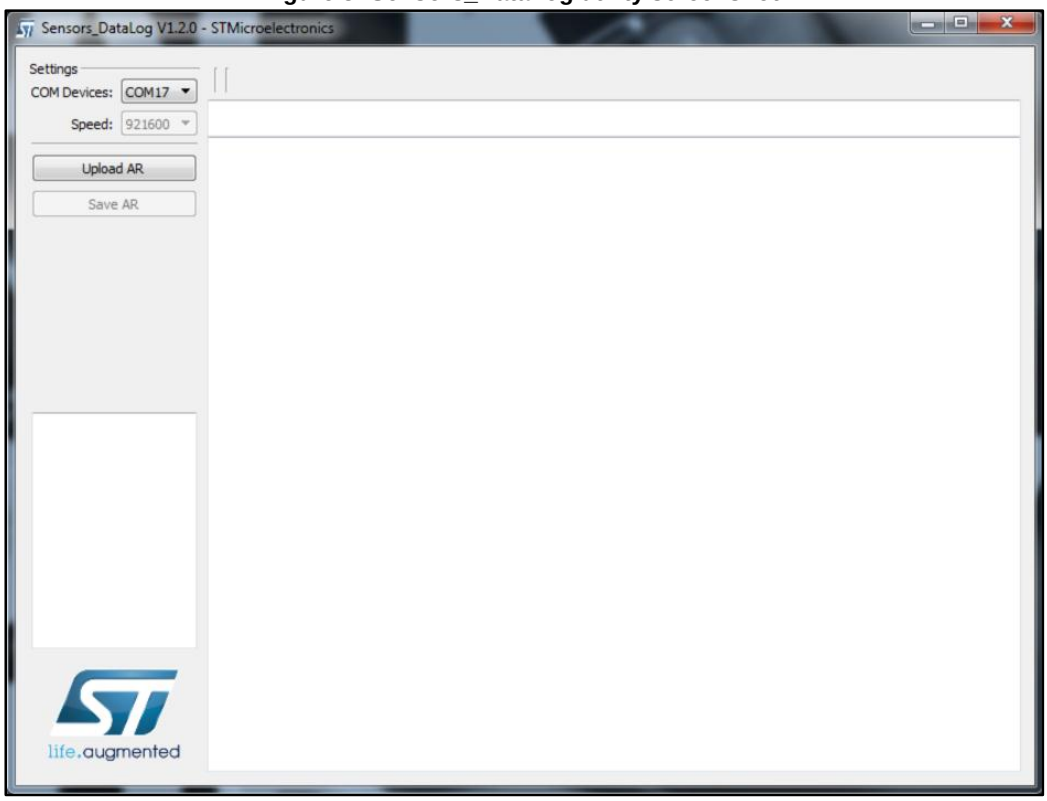
1. Connect the STM32 Nucleo board to the PC with a USB cable (jumper JP1 not fitted)
2. Find the ST COM port in Windows Device Manager (COM17 in the figure below)

**Figure 7: Windows Device Manager**



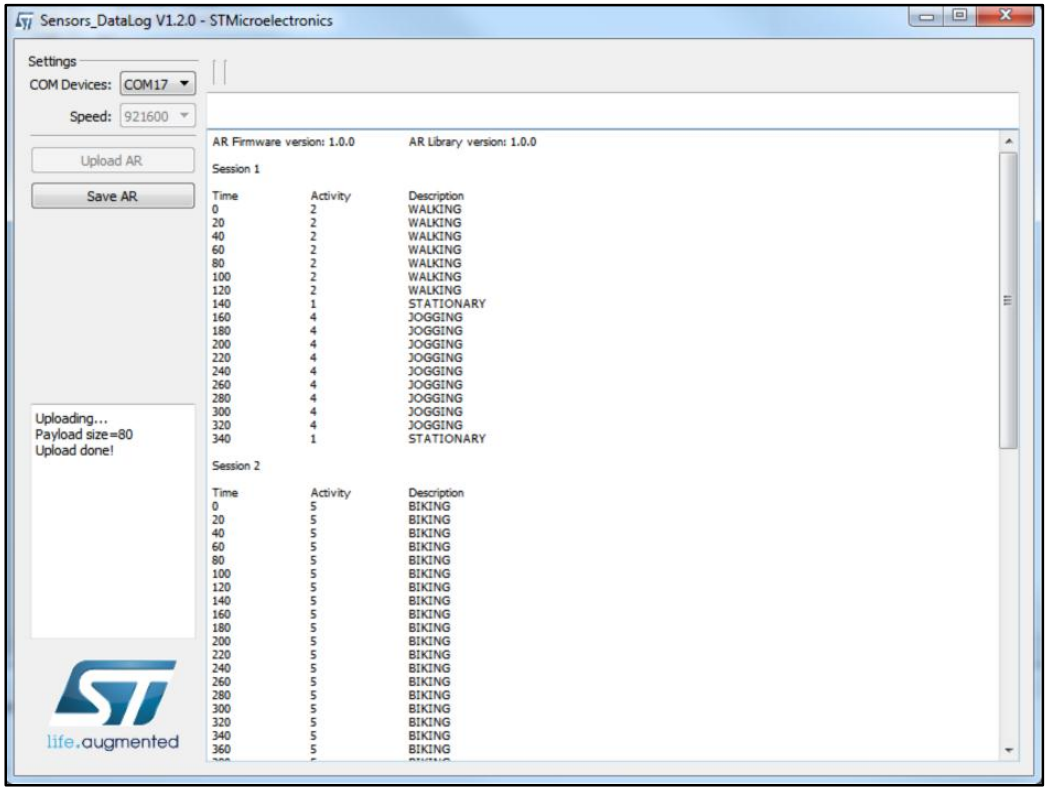
3 Launch Sensors_DataLog.exe and check that the COM Device number for the current expansion board is correct.

**Figure 8: Sensors_DataLog utility screenshot**



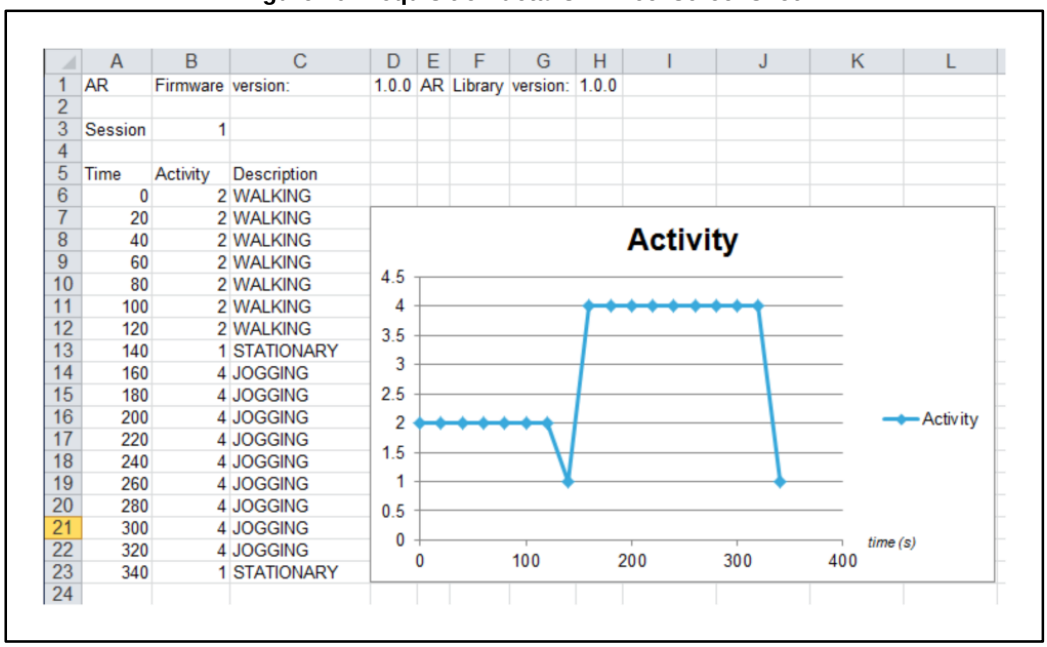
4 Press *Upload AR* to upload stored activity data to the PC GUI. This operation automatically deletes acquired data from microcontroller. The figure below shows how the data is arranged in *Time*, *Activity* and *Description* columns. Activities with a duration of less than 20 seconds are not memorized.

**Figure 9: Sensors_DataLog utility screenshot: upload data**



5 Press the *Save AR* button in the above figure to save the data in a .tsv file located in a new folder called *SensorsDataLog*. A closer look at our example reveals the user walked for two minutes and, after a very short rest (approximately 20 seconds), jogged for three minutes before resting and stopping data acquisition. The acquired data may be exported and plotted in an Excel file, as shown below.

**Figure 10: Acquisition details – Excel screenshot**



| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | AR | Firmware | version: | 1.0.0 | AR | Library | version: | 1.0.0 |
| 2 | | | | | | | | |
| 3 | Session | 1 | | | | | | |
| 4 | | | | | | | | |
| 5 | Time | Activity | Description | | | | | |
| 6 | 0 | 2 | WALKING | | | | | |
| 7 | 20 | 2 | WALKING | | | | | |
| 8 | 40 | 2 | WALKING | | | | | |
| 9 | 60 | 2 | WALKING | | | | | |
| 10 | 80 | 2 | WALKING | | | | | |
| 11 | 100 | 2 | WALKING | | | | | |
| 12 | 120 | 2 | WALKING | | | | | |
| 13 | 140 | 1 | STATIONARY | | | | | |
| 14 | 160 | 4 | JOGGING | | | | | |
| 15 | 180 | 4 | JOGGING | | | | | |
| 16 | 200 | 4 | JOGGING | | | | | |
| 17 | 220 | 4 | JOGGING | | | | | |
| 18 | 240 | 4 | JOGGING | | | | | |
| 19 | 260 | 4 | JOGGING | | | | | |
| 20 | 280 | 4 | JOGGING | | | | | |
| 21 | 300 | 4 | JOGGING | | | | | |
| 22 | 320 | 4 | JOGGING | | | | | |
| 23 | 340 | 1 | STATIONARY | | | | | |
| 24 | | | | | | | | |



### 1.5.3 Data storage

The example application allows the user to detect activity performed and store it in MCU flash memory. Data is automatically saved every 5 minutes to avoid excessive data loss in case of an unforeseen power fault. Data is also stored when the user stops acquisition by pressing button B1 to display data by LED.

When stored data is retrieved via the GUI (see *Section 1.5.2: "Sensors_DataLog utility"*), the MCU flash sector dedicated to this purpose is cleared.

LED LD2 should be OFF at power-on, unless:

- the flash memory is full or almost full
- the license number is incorrect

In the first case, the user can continue using the board for normal activity recognition and data storage (if enough space is available) as described in *Section 1.5.1: "Activity acquisition working mode"*, by pushing the user button (LED switches off in 5 seconds). Data continues to be stored until the reserved sector is full, at which time the algorithm keeps running, but data is no longer stored.

The flash sector dedicated to data storage is 128 KB, allowing memorization of more than 16,000 data sets, this equates to:

- a minimum of 91 hours (activity changes and a new buffer is stored every 20 seconds)
- a maximum of 1365 hours (activity never changes and data is automatically stored every 5 minutes).

If LED LD2 switches ON at reset, no more than 1400 Bytes are free; i.e., from one hour recording time if data is stored every 20 seconds to 15 hours if data is automatically saved every five minutes.

If a large amount of data needs to be stored and no PC is available for data download and flash memory clean up, the MCU memory can be erased when LED LD2 is ON by holding the user push button down for at least 5 seconds. LED LD2 switches OFF and then starts blinking to indicate that acquisition mode has been activated and the activity data stored in the MCU has been erased.

If LED LD2 does not switch OFF after this operation, it means that the license number is wrong. In this case no action is allowed and the user must program the STM32 Nucleo board with the correct license number (see *Section 3.5.4: "osxMotionAR license wizard"* for details on how to obtain a license).

# 2 Algorithm performance

The activity recognition (AR) algorithm only uses data from the accelerometer and runs at a low frequency (16 Hz) to reduction power consumption.

The table below shows the performance of the AR algorithm in terms of recognition success rates. The data is based on 600 data sets collected from 71 individuals.

**Table 3: Performance data**

| Activity | Detection probability | Best performance | Vulnerable | Carry positions |
|---|---|---|---|---|
| Stationary | 91.41% | | Holding in hand and heavy texting | all: trousers pocket, shirt pocket, back pocket, near the head, etc. |
| Walking | 98.85% | step rate ≥ 1.4 step/s | step rate ≤ 1.2 step/s | all |
| Fast walking | 98.88% | step rate ≥ 2.0 step/s | | all |
| Jogging | 98.76% | step rate ≥ 2.2 step/s | | trouser pocket, arm swing, in-hand |
| Biking | 86.41%. | outdoor speed ≥ 11 Km/h | duration < 1 minute; speed < 8 Km/h | backpack, shirt pocket, trouser pocket |
| Driving | 83.57% | speed ≥ 48 Km/h | passenger seat, glove compartment. | cup holder, dash board, shirt pocket, trousers pocket |

# 3 System setup guide

## 3.1 Hardware description

This section describes the hardware components required to develop a sensor-based application.

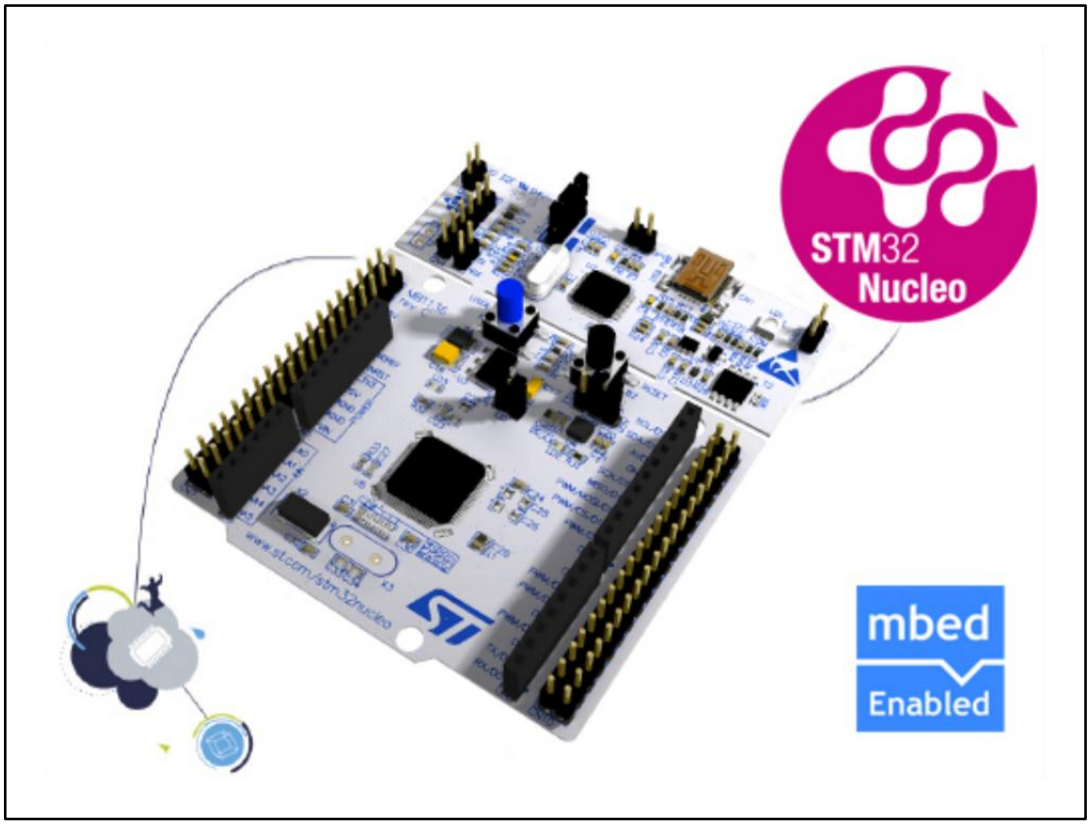
### 3.1.1 STM32 Nucleo platform

The STM32 Nucleo boards represent an affordable and flexible solution for users to implement new ideas and build prototypes with any STM32 microcontroller lines. Arduino™ connectivity support and ST Morpho headers make it easy to expand the functionality of the STM32 Nucleo open development platform with a wide range of specialized expansion boards.

The STM32 Nucleo board does not require any separate probes as it integrates the ST-LINK/V2-1 debugger/programmer, and it is bundled with the STM32 comprehensive software HAL library together with various packaged software examples.

Information about the STM32 Nucleo boards is available on www.st.com at: *http://www.st.com/stm32nucleo*

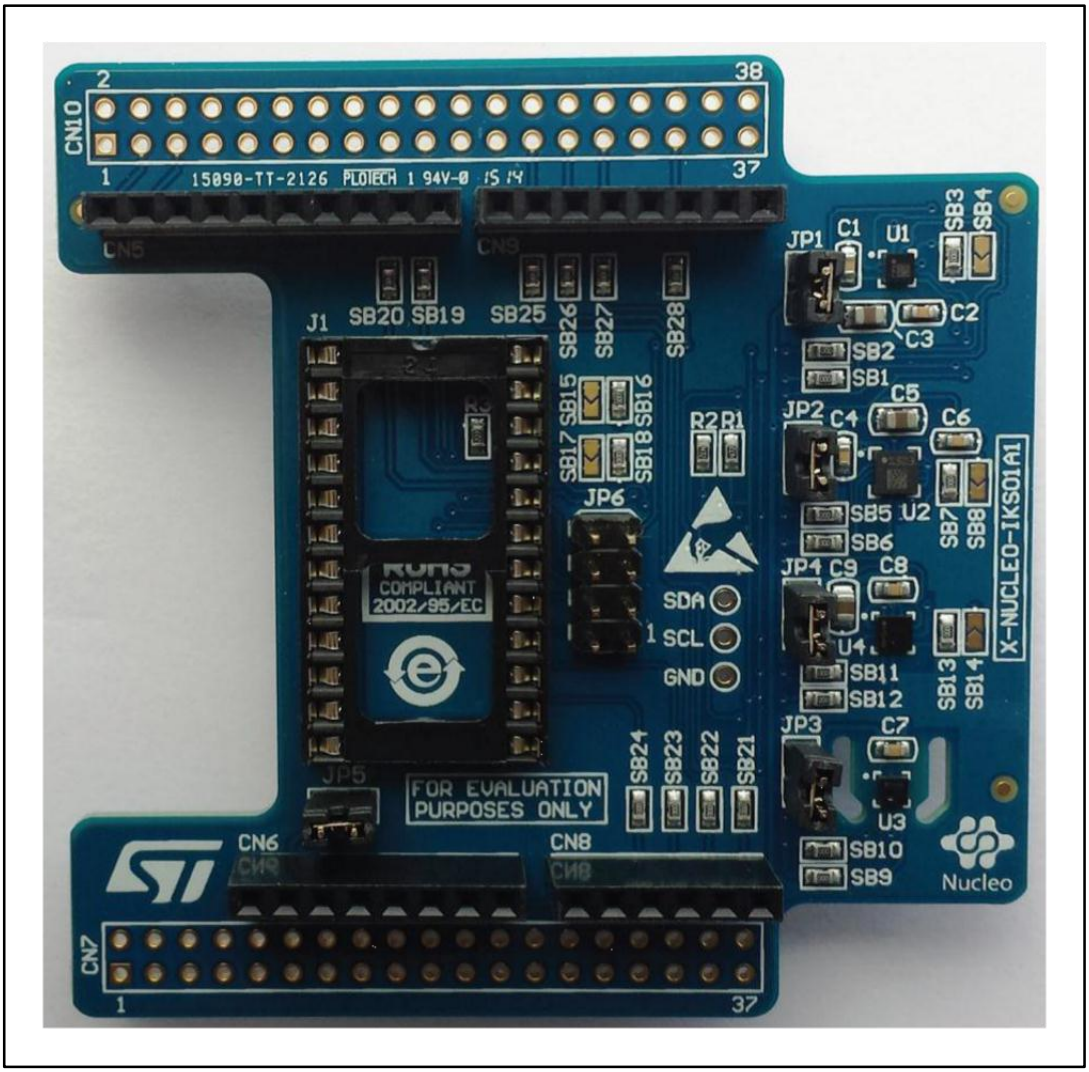
**Figure 11: STM32 Nucleo board**



## X-NUCLEO-IKS01A1 expansion board

The X-NUCLEO-IKS01A1 figured below is a sensor expansion board for use with the STM32 Nucleo system. It is also compatible with the Arduino UNO R3 connector layout, and is designed around the STMicroelectronics humidity (HTS221), pressure (LPS25HB) and motion sensors (LIS3MDL and LSM6DS0). The X-NUCLEO-IKS01A1 interfaces with the STM32 MCU via an I²C pin, and the user can change the default I²C address and the device IRQ by changing one resistor on the evaluation board.

**Figure 12: STM32 Nucleo board**




Information about the X-NUCLEO-IKS01A1 expansion board is available on www.st.com at: *http://www.st.com/x-nucleo*.

The LSM6DS3 adapter board in the figure below can be plugged on top of the X-NUCLEO-IKS01A1 expansion board, as shown in *Figure 14: "Sensor expansion board and adapter connected to the STM32 Nucleo"*.

**Figure 13: LSM6DS3 adapter board**

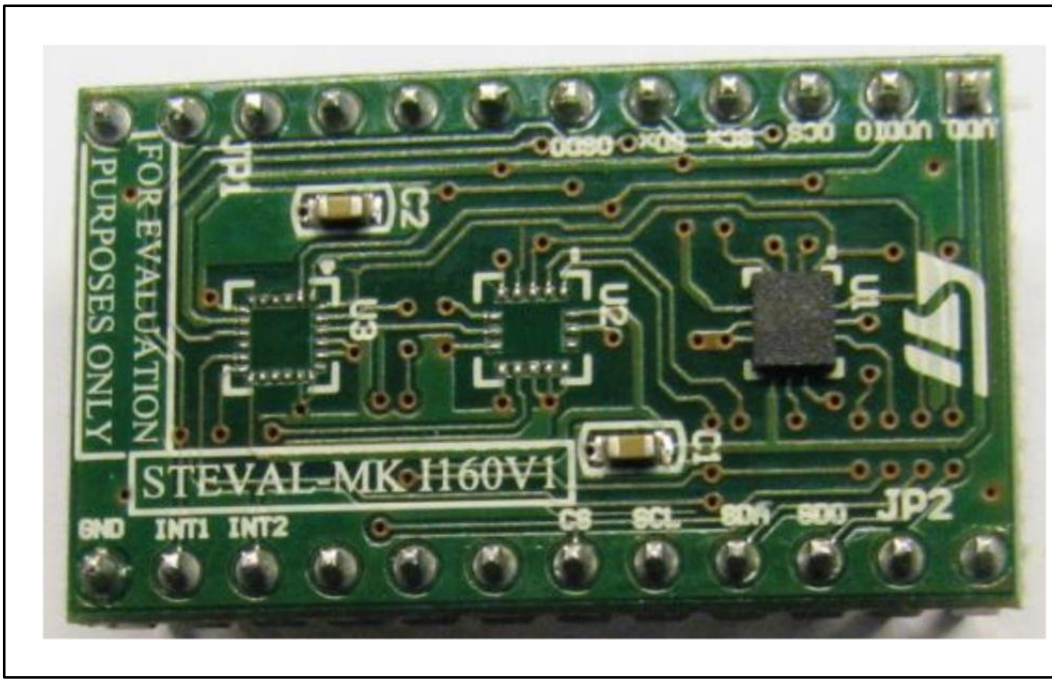
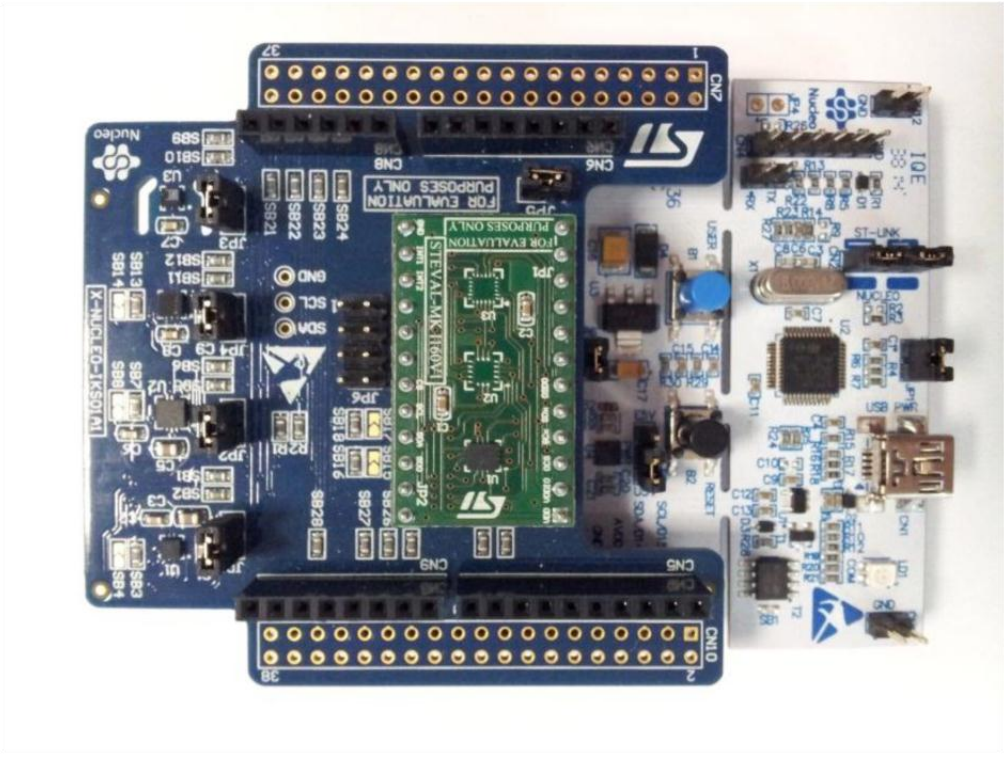



**Figure 14: Sensor expansion board and adapter connected to the STM32 Nucleo**



## 3.2 Software descritption

The following software components are required to set up a suitable development environment for creating applications using the osxMotionAR library for the STM32 Nucleo, equipped with the sensor expansion board:

- X-CUBE-MEMS1: an expansion for STM32Cube dedicated to sensor application development. The X-CUBE-MEMS1 firmware and related documentation is available on st.com.
- osxMotionAR: an add-on software package for X-CUBE-MEMS1 that provides activity recognition APIs. The osxMotionAR firmware and related documentation is available on st.com.
- Development tool-chain and compiler: The STM32Cube expansion software supports the following three IDEs:
  - IAR Embedded Workbench for ARM® (EWARM) toolchain + ST-LINK
  - µVision(MDK-ARM) toolchain + ST-LINK
  - System Workbench for STM32

## 3.3 Hardware setup

The following hardware components are required:

- One STM32 Nucleo development platform (order code: NUCLEO-F401RE)
- One sensor expansion board (order code: X-NUCLEO-IKS01A1) optionally mounted with the LSM6DS3 adapter board (order code: STEVAL-MKI160V1)
- One USB type A to Mini-B USB cable to connect the STM32 Nucleo to the PC
- One battery pack to run the application example

## 3.4 Software setup

This section lists the minimum requirements for the developer to set up the SDK, run the sample testing scenario based on the GUI utility and customize applications.

### 3.4.1 Development tool-chains and compilers

Please select one of the integrated development environments supported by the STM32Cube expansion software, and read the system requirements and setup information provided by the selected IDE provider.

### 3.4.2 PC utility

The Sensors DataLog utility for PC has following minimum requirements:

- PC with Intel or AMD processor running one of the following Microsoft operating systems:
- Windows XP SP3
- Windows Vista
- Windows 7
- At least 128 MBs of RAM
- 2 X USB ports
- 40 MB of hard disk space

## 3.5 System setup

This section describes how to set up different hardware components before writing and executing an application on the STM32 Nucleo board with the sensor expansion board.

### 3.5.1 STM32 Nucleo and sensor expansion boards setup

The STM32 Nucleo board includes the ST-LINK/V2-1 debugger/programmer. The developer can download the relevant version of the ST-LINK/V2-1 USB driver by accessing the STSW-LINK008 or STSW-LINK009 on www.st.com (according to which MS Windows OS is used).

The sensor expansion board X-NUCLEO-IKS01A1 can be easily connected to the STM32 Nucleo motherboard through the Arduino UNO R3 extension connector (see *Figure 14: "Sensor expansion board and adapter connected to the STM32 Nucleo"*). The LSM6DS3 adapter board (STEVAL-MKI160V1) is plugged on top of the expansion board. The sensor expansion boards are capable of interfacing with the external STM32 microcontroller on the STM32 Nucleo via an inter-integrated circuit (I²C) transport layer.

### 3.5.2 Sensors_DataLog GUI setup

The Sensors_DataLog GUI included in the X-CUBE-MEMS1 software package is a graphical user interface that can be used to obtain activity data previously stored on MCU. Please see *Section 1.5.2: "Sensors_DataLog utility"* for a description of the how this PC utility works.

This utility retrieves data from the connected STM32 MCU flash memory and stores it in a table format which can be exported for offline analysis.

In order to use the Sensors_DataLog GUI, the user has to correctly set up the hardware and software.

The utility can be launched by simply double-clicking on the Sensors_DataLog.exe file, located in the "Utilities\PC_software\Sensors_DataLog" folder.

### 3.5.3 osxMotionAR installer setup

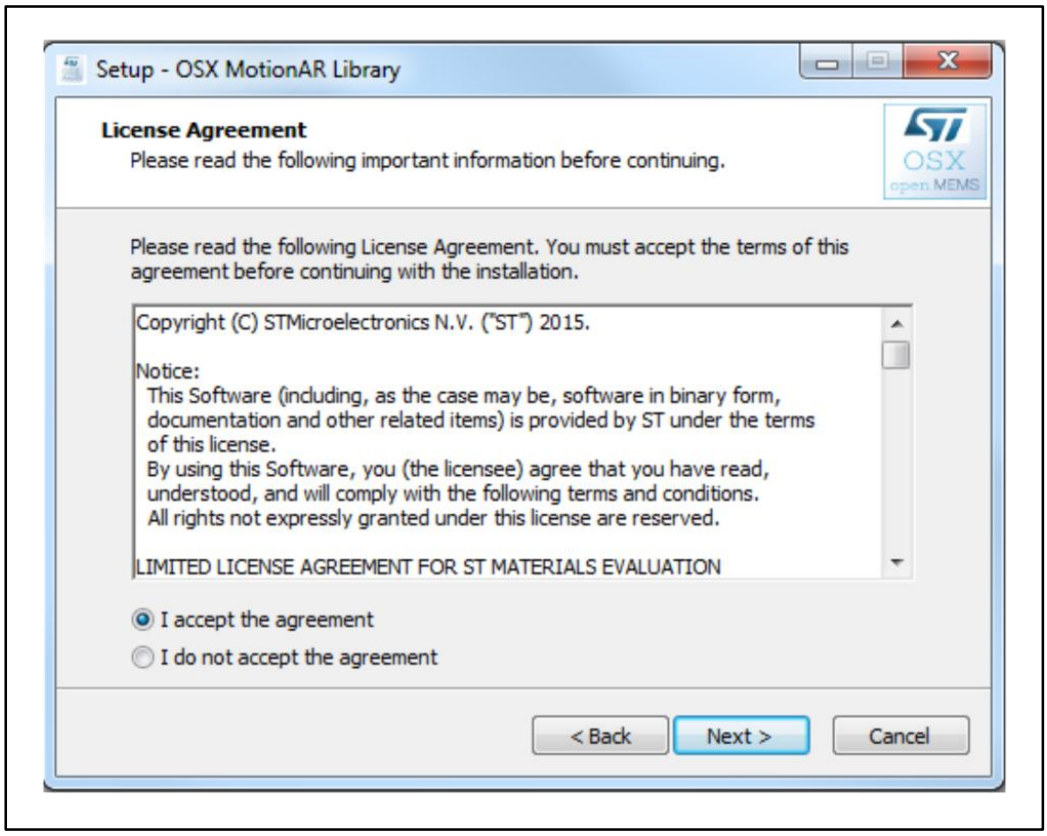
The osxMotionAR software package is equipped with a Windows installer (osxMotionAR_Setup_vXXX.exe), which guides the user through the software package installation. The installer also includes the osx License Wizard tool, which allows the user to automatically obtain a valid node-locked license for their STM32 Nucleo board. The installer for the license wizard is described in *Section 3.5.4: "osxMotionAR license wizard"*.

1 Before running the installer, download the latest release of the X-CUBEMEMS1 software package and unzip this package in the relative workspace. For example, if the X-CUBE-MEMS1 package is located in "C:\workspace\STM32CubeExpansion_MEMS1_VX.X.X", the installer will display welcome window shown in the figure below.

**Figure 15: osxMotionAR installer screenshot 1**

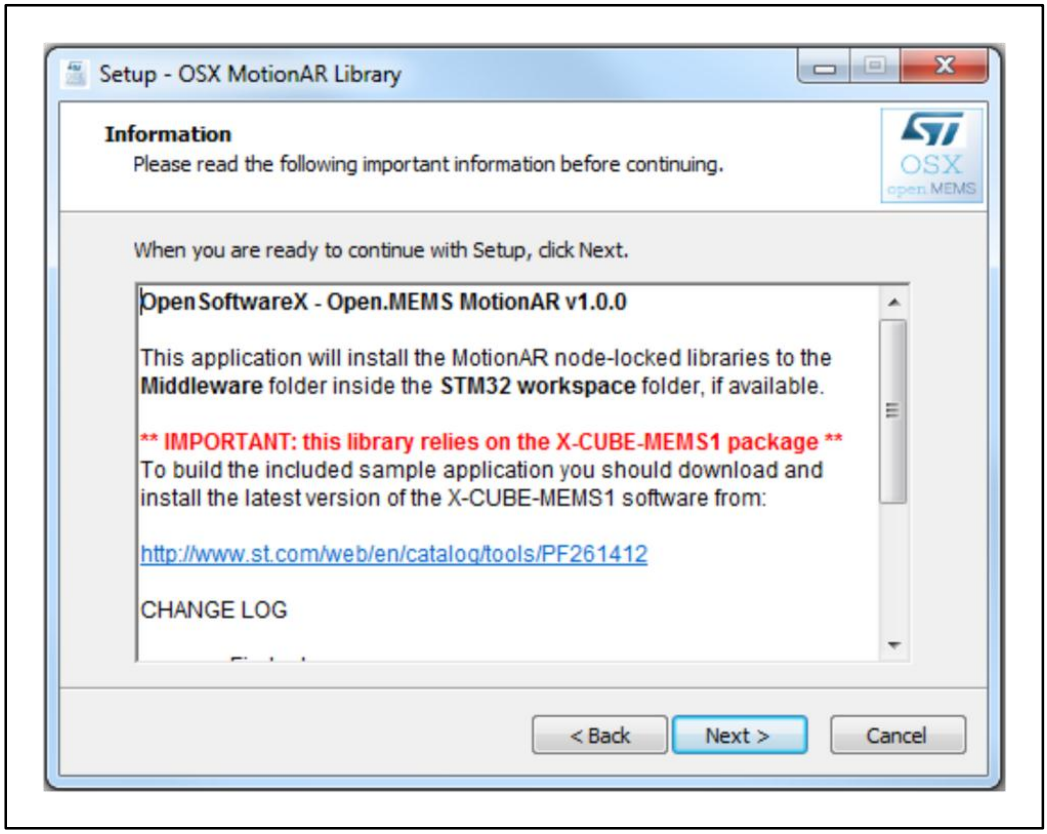
2 The license agreement must be accepted, as shown in the figure below.

**Figure 16: osxMotionAR installer screenshot 2**


Setup - OSX MotionAR Library
License Agreement
Please read the following important information before continuing.
OSX
open MEMS
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.
Copyright (C) STMicroelectronics N.V. ("ST") 2015.
Notice:
This Software (including, as the case may be, software in binary form, documentation and other related items) is provided by ST under the terms of this license.
By using this Software, you (the licensee) agree that you have read, understood, and will comply with the following terms and conditions.
All rights not expressly granted under this license are reserved.
LIMITED LICENSE AGREEMENT FOR ST MATERIALS EVALUATION
I accept the agreement
I do not accept the agreement
< Back
Next >
Cancel

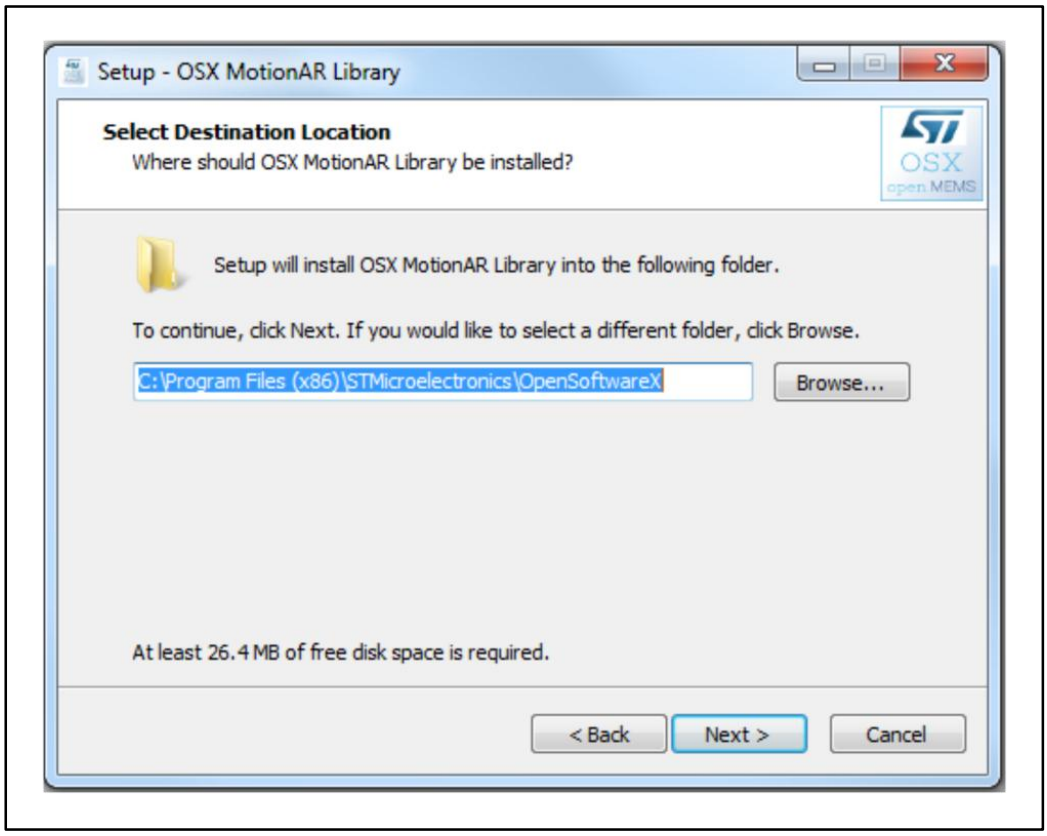
3 The installer provides information such as the requirements of the latest release of the X-CUBE-MEMS1 software package.

**Figure 17: osxMotionAR installer screenshot 3**


Setup - OSX MotionAR Library
Information
Please read the following important information before continuing.
OSX
open.MEMS
When you are ready to continue with Setup, click Next.
OpenSoftwareX - Open.MEMS MotionAR v1.0.0
This application will install the MotionAR node-locked libraries to the Middleware folder inside the STM32 workspace folder, if available.
** IMPORTANT: this library relies on the X-CUBE-MEMS1 package **
To build the included sample application you should download and install the latest version of the X-CUBE-MEMS1 software from:
http://www.st.com/web/en/catalog/tools/PF261412
CHANGE LOG
< Back
Next >
Cancel

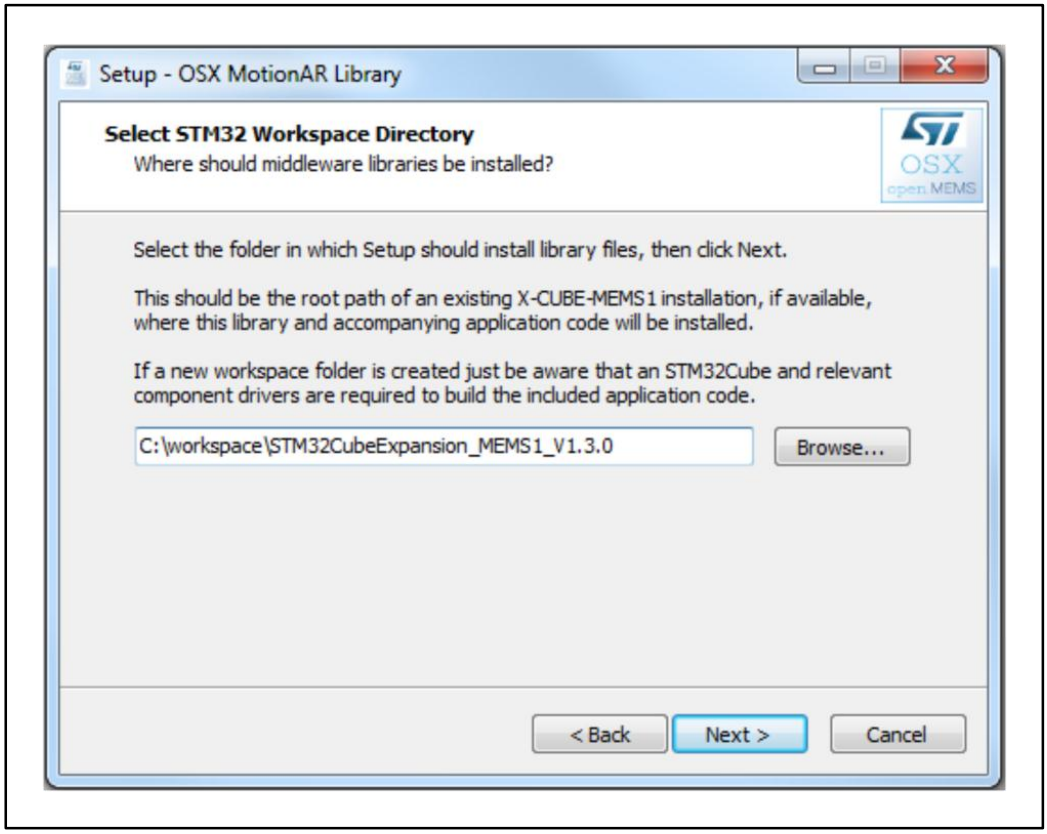
4 The installer then asks for the destination location of the osxMotionAR library.

**Figure 18: osxMotionAR installer screenshot 4**


Setup - OSX MotionAR Library
Select Destination Location
Where should OSX MotionAR Library be installed?
OSX
open.MEMS
Setup will install OSX MotionAR Library into the following folder.
To continue, click Next. If you would like to select a different folder, click Browse.
C:\Program Files (x86)\STMicroelectronics\OpenSoftwareX
Browse...
At least 26.4 MB of free disk space is required.
< Back
Next >
Cancel

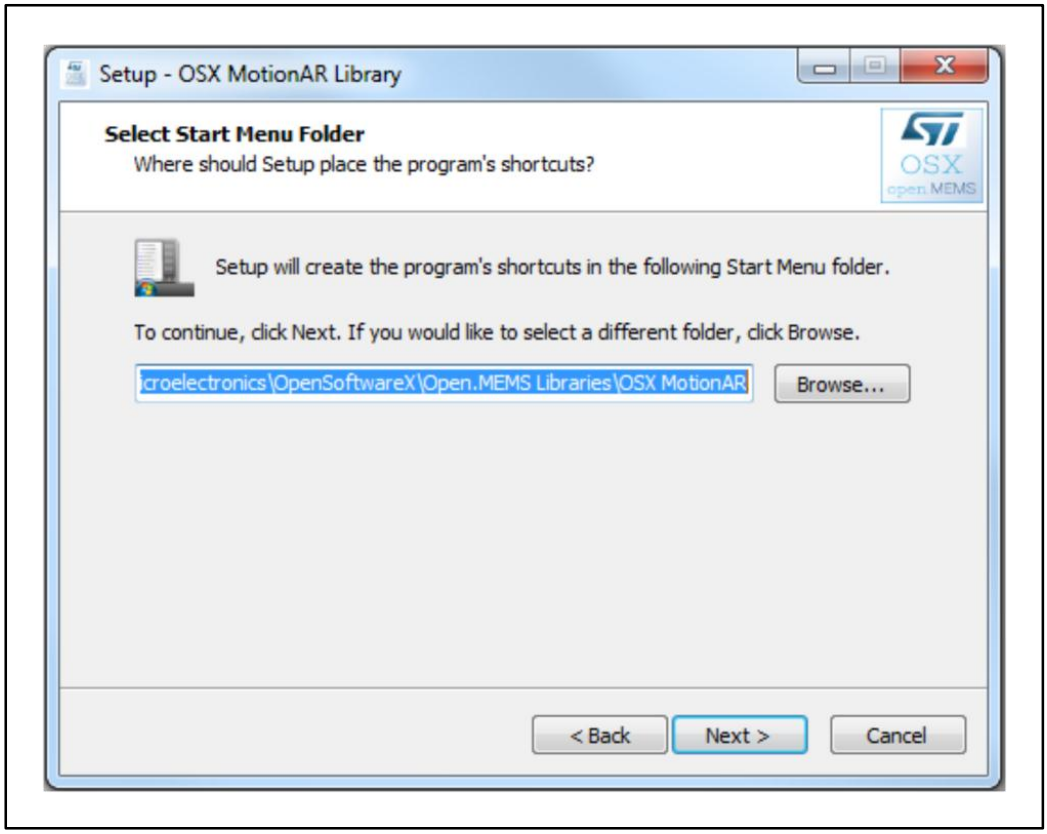
5 The user must then provide the path to the X-CUBE-MEMS1 package. It is imperative to insert the correct path to the X-CUBEMEMS1 package, otherwise the sample application will not compile. It is the path where the folders "Documentation", "Projects", "Drivers", "Utilities", etc.., contained in the X-CUBE-MEMS1 software package are located. In this example, it is "C:\workspace\STM32CubeExpansion_MEMS1_V1.3.0".

**Figure 19: osxMotionAR installer screenshot 5**


Setup - OSX MotionAR Library
Select STM32 Workspace Directory
Where should middleware libraries be installed?
OSX
open.MEMS
Select the folder in which Setup should install library files, then click Next.
This should be the root path of an existing X-CUBE-MEMS1 installation, if available, where this library and accompanying application code will be installed.
If a new workspace folder is created just be aware that an STM32Cube and relevant component drivers are required to build the included application code.
C:\workspace\STM32CubeExpansion_MEMS1_V1.3.0
Browse...
< Back
Next >
Cancel

6 The user must then provide the path to the Start menu folder where the shortcuts are installed.

**Figure 20: osxMotionAR installer screenshot 6**


Setup - OSX MotionAR Library
Select Start Menu Folder
Where should Setup place the program's shortcuts?
OSX
open.MEMS
Setup will create the program's shortcuts in the following Start Menu folder.
To continue, click Next. If you would like to select a different folder, click Browse.
icroelectronics\OpenSoftwareX\Open.MEMS Libraries\OSX MotionAR
Browse...
< Back
Next >
Cancel

This completes the osxMotionAR installation.

### 3.5.4 osxMotionAR license wizard

The osxMotionAR engine is provided as a node-locked library which allows derivative firmware images to run on a specific STM32 Nucleo device only. License activation codes must to be requested to ST and included in the project (and becomes part of the build process) prior to attempting its usage. The resulting firmware binary image will therefore be node-locked.

The License wizard allows the user to automatically obtain a valid node-locked license for their STM32 Nucleo board. Before running this tool, connect the STM32 Nucleo to be linked to the node-locked license via USB cable.

The user will receive an email with the license to be included in the Middlewares\ST\osxMotionAR folder of the workspace.

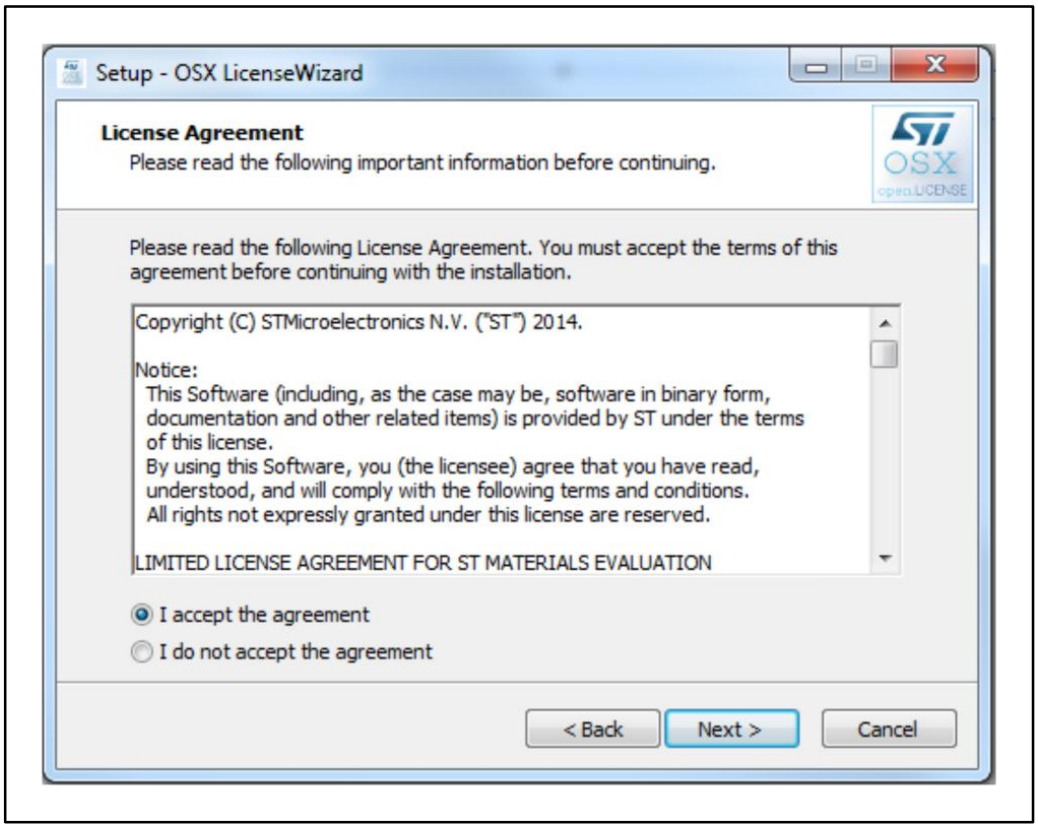
The steps below describe the licensing procedure in detail.

1 The figure below shows the welcome screen.

**Figure 21: osx License Wizard screenshot 1**

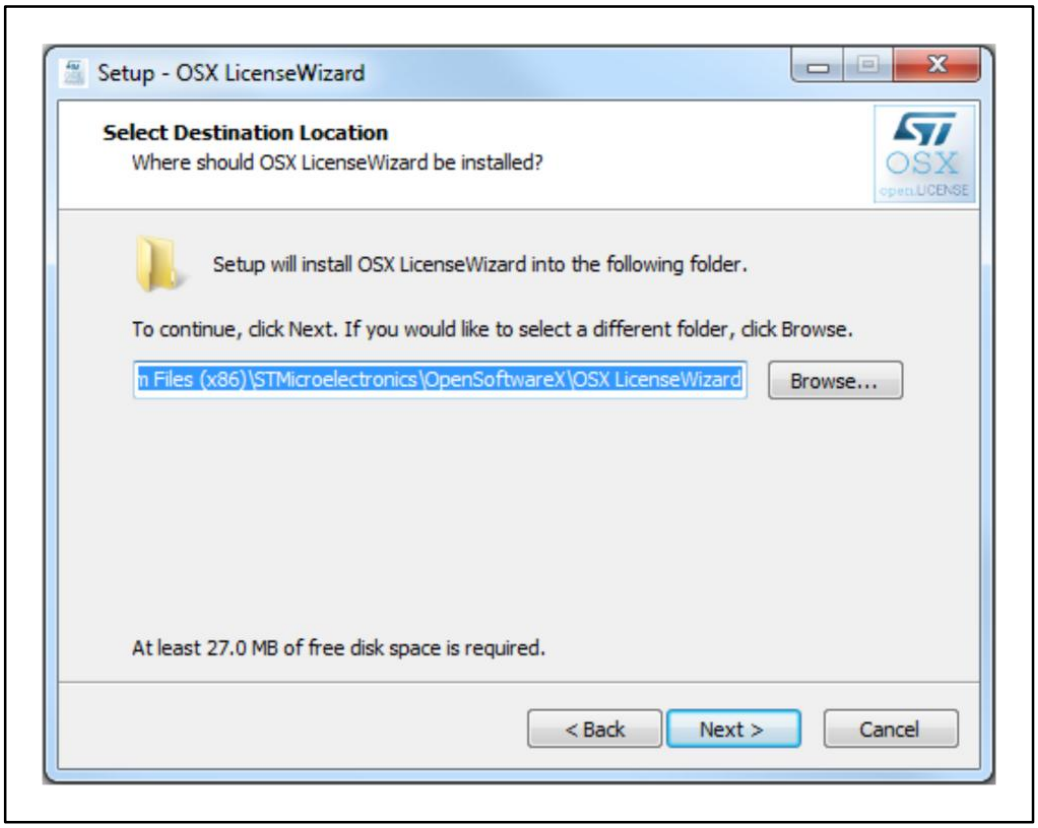
2 The user needs to accept the license agreement to proceed with the installation.

**Figure 22: osx License Wizard screenshot 2**


Setup - OSX LicenseWizard
License Agreement
Please read the following important information before continuing.
Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.
Copyright (C) STMicroelectronics N.V. ("ST") 2014.
Notice:
This Software (including, as the case may be, software in binary form, documentation and other related items) is provided by ST under the terms of this license.
By using this Software, you (the licensee) agree that you have read, understood, and will comply with the following terms and conditions.
All rights not expressly granted under this license are reserved.
LIMITED LICENSE AGREEMENT FOR ST MATERIALS EVALUATION
I accept the agreement
I do not accept the agreement
< Back
Next >
Cancel

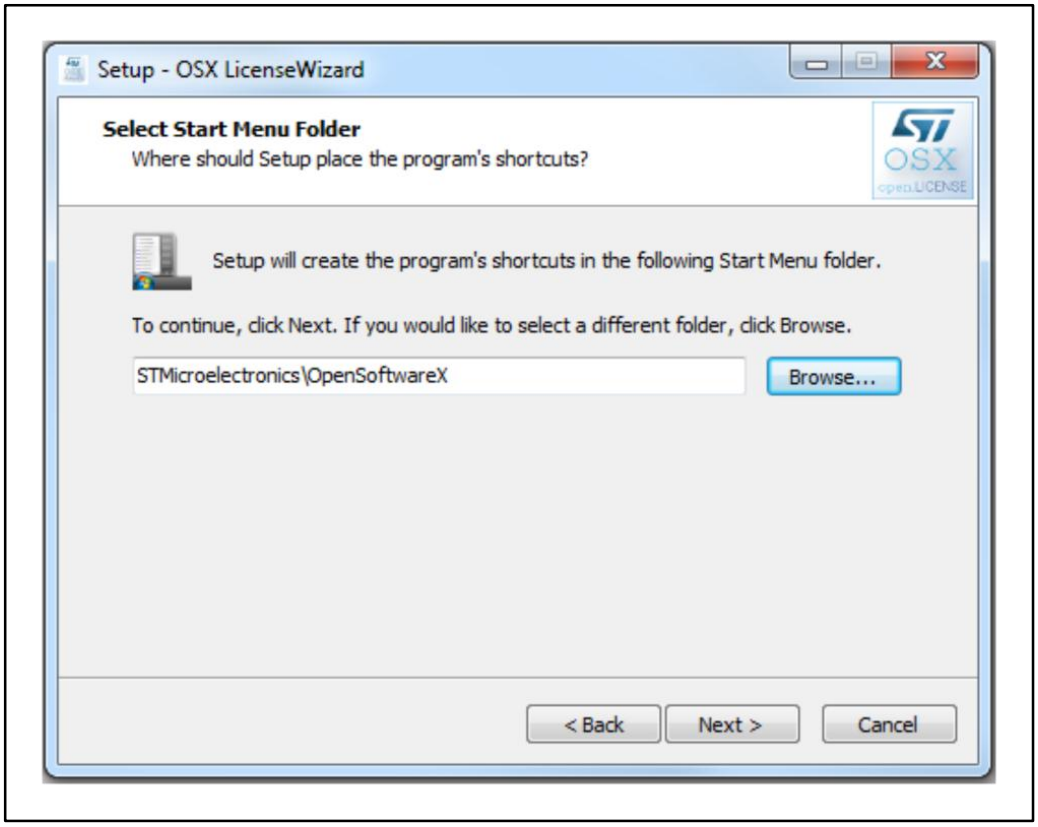
3 The license then asks for the destination location of the osx License Wizard.

**Figure 23: osx License Wizard screenshot 3**


Setup - OSX LicenseWizard
Select Destination Location
Where should OSX LicenseWizard be installed?
OSX
Setup will install OSX LicenseWizard into the following folder.
To continue, click Next. If you would like to select a different folder, click Browse.
n Files (x86)\STMicroelectronics\OpenSoftwareX\OSX LicenseWizard
Browse...
At least 27.0 MB of free disk space is required.
< Back
Next >
Cancel

4 The user must then provide the path to the Start menu folder where the shortcuts are installed.

**Figure 24: osx License Wizard screenshot 4**


Setup - OSX LicenseWizard
Select Start Menu Folder
Where should Setup place the program's shortcuts?
OSX
Setup will create the program's shortcuts in the following Start Menu folder.
To continue, click Next. If you would like to select a different folder, click Browse.
STMicroelectronics\OpenSoftwareX
Browse...
< Back
Next >
Cancel

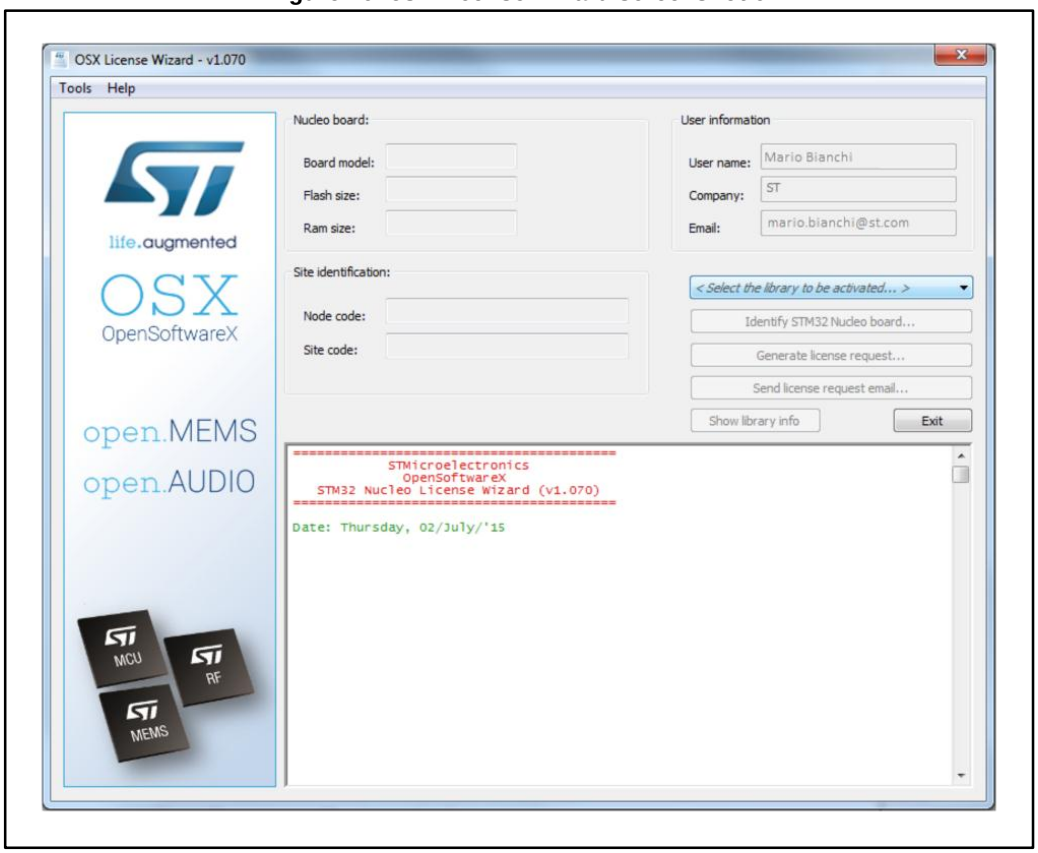
This step completes the osx License Wizard software installation.

5 The osx License Wizard needs to access some information on the STM32 Nucleo board in order to create the request for the node-locked license. For this reason, the osx License Wizard requires the installation of some additional packages ("Microsoft VS 2013 redistributable" and "STM32 ST-LINK Utility"), if the user has not already done so

**Figure 25: osx License Wizard screenshot 5**

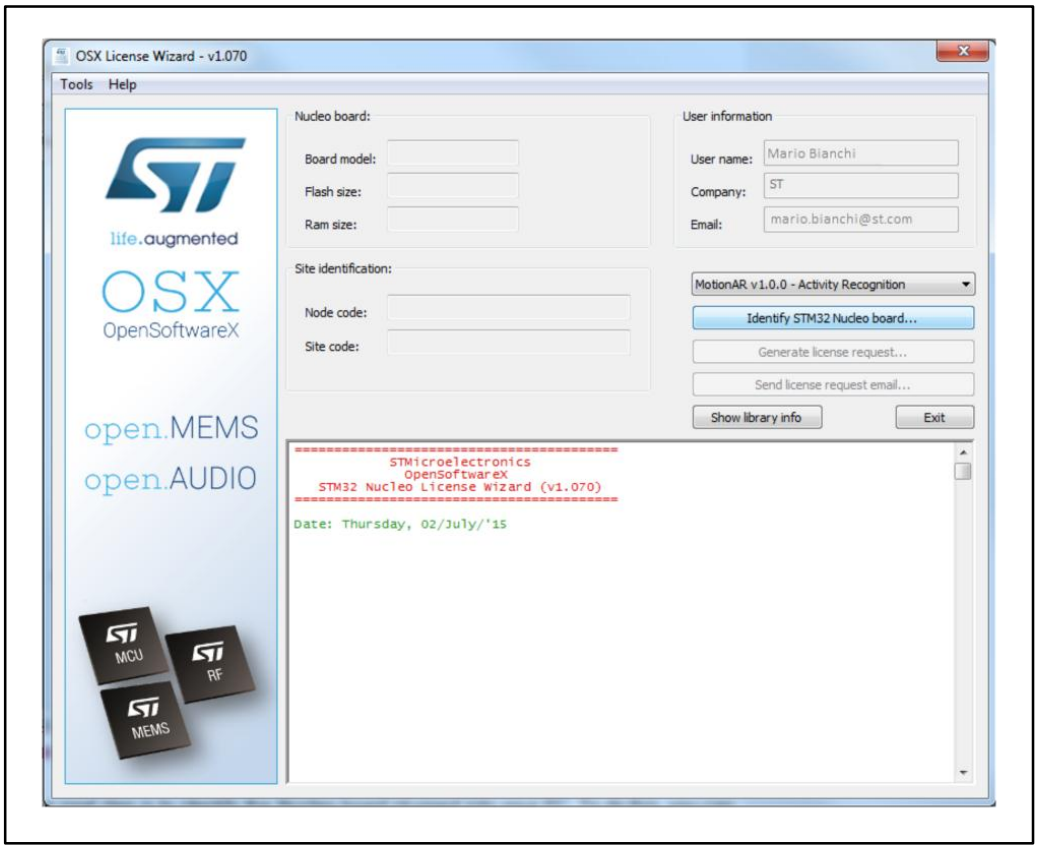
6 Before launching the osx License Wizard, connect the STM32 Nucleo board to be linked to the node-locked license via USB cable. First, select the library to be activated as per the figure below.

**Figure 26: osx License Wizard screenshot 6**



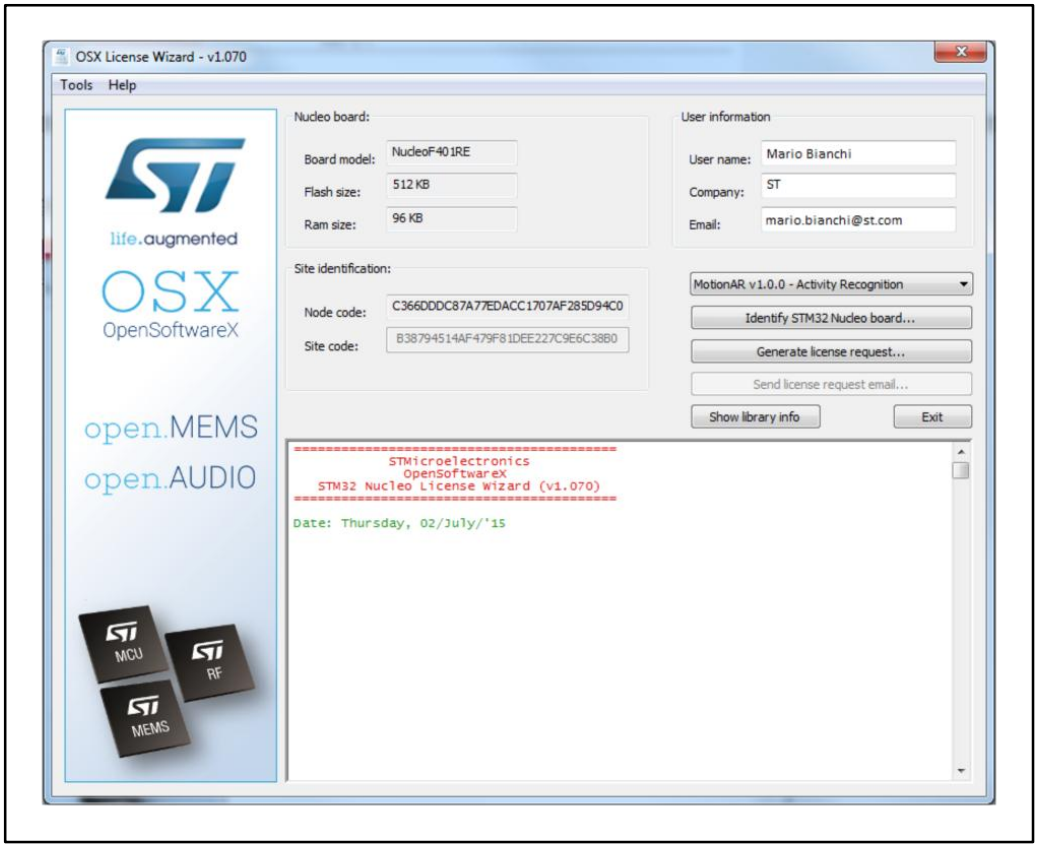
7 Next click on the "Identify STM32 Nucleo board" button.

**Figure 27: osx License Wizard screenshot 7**



8 At this point, information about the connected STM32 Nucleo board is available to the user together with a node code associated with the same board.

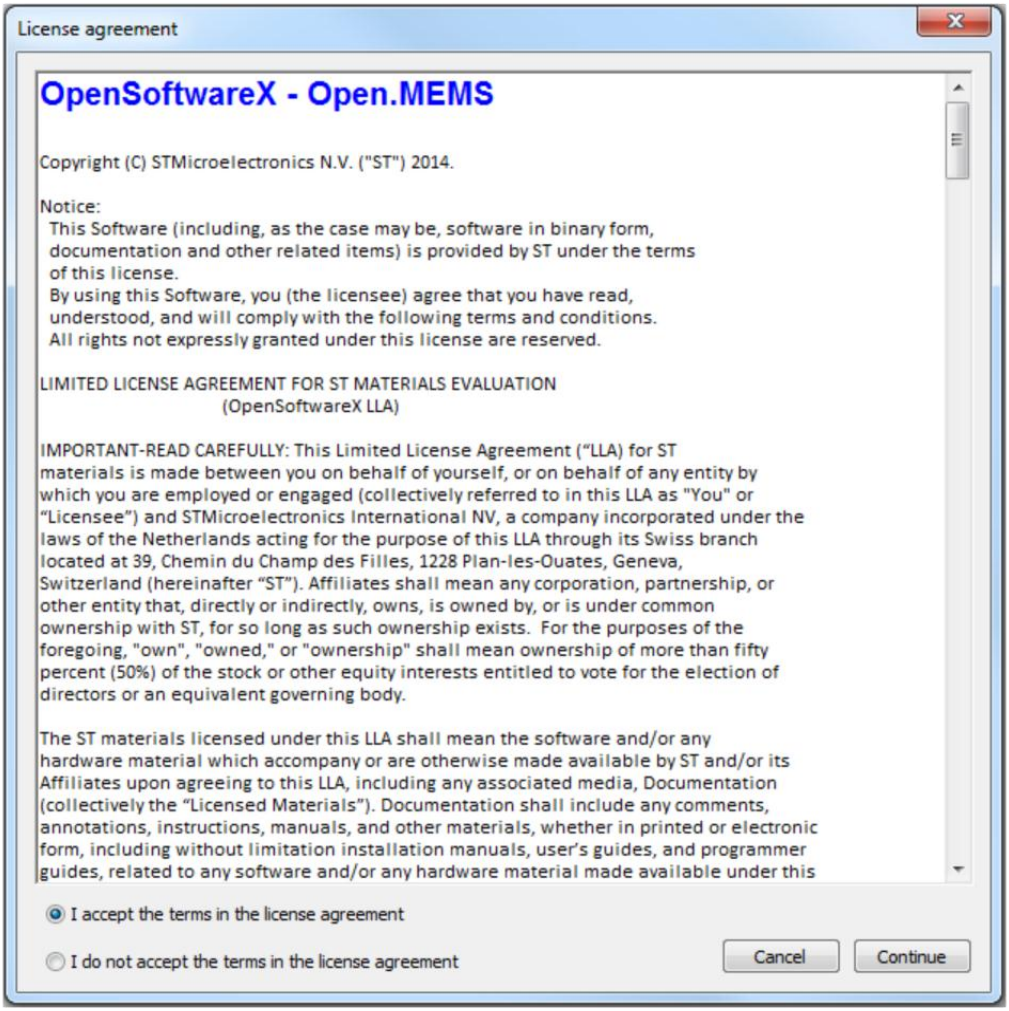
**Figure 28: osx License Wizard screenshot 8**




Complete the form, editing the "User name", "Company" and "Email" and click on "Generate license request".

9 A new window concerning the license agreement will appear and user can accept the conditions by clicking the Continue button to proceed.

**Figure 29: osx License Wizard screenshot 9**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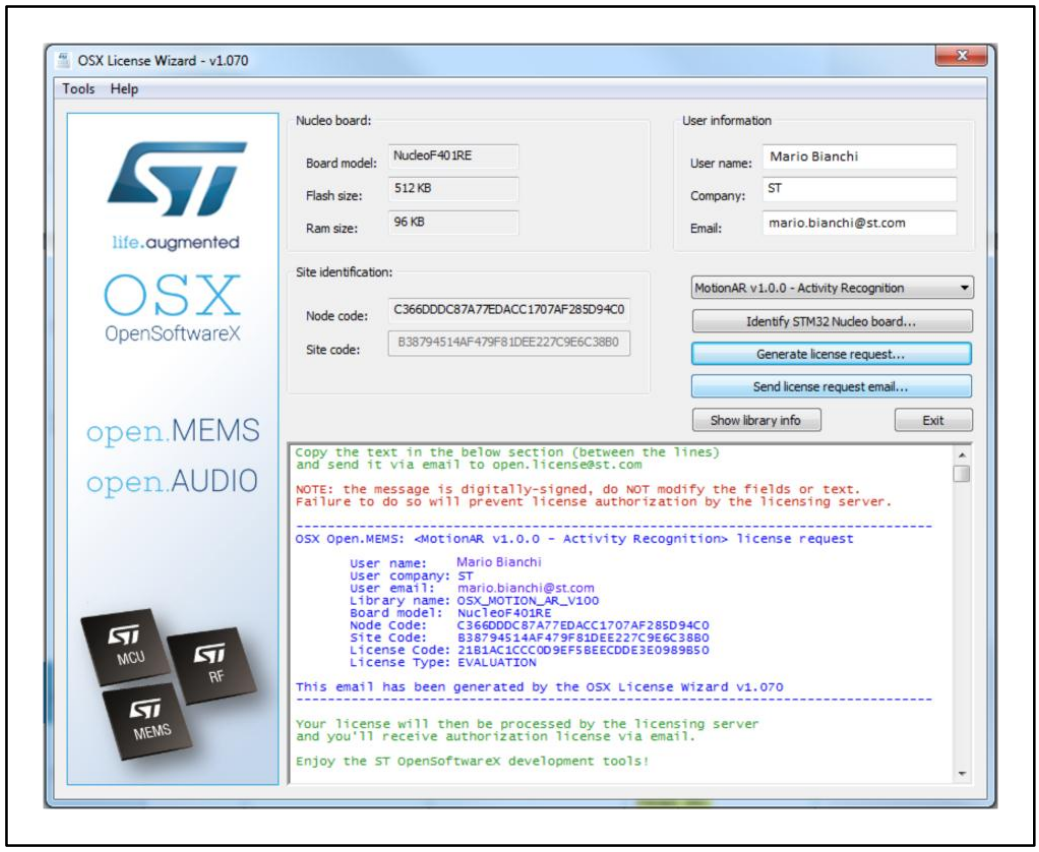
I accept the terms in the license agreement
I do not accept the terms in the license agreement
Cancel
Continue

10 Click the "Send license request email" button shown in the figure below.

**Figure 30: osx License Wizard screenshot 10**




11 Once the license activation codes have been received, edit the content of the osx_license.h file with the license number. You must also delete or comment the "#error...." line, found in the Middlewares\ST\osxMotionAR folder of your workspace.

# 4 Acronyms and abbreviations

**Table 4: Acronyms**

| Acronym | Description |
|---|---|
| HAL | Hardware Abstraction Layer |
| API | Application programming interface |
| BSP | Board support package |
| IDE | Integrated Development Environments |
| NED | x-North, y-East, z-Down |
| ENU | x-East, y-North, z-Up |
| SEU | x-South, y-East, z-Up |
| GUI | Graphical User Interface |
| SDK | Software development kit |

# 5 References

- *UM1859: Getting started with the X-CUBE-MEMS1 motion MEMS and environmental sensor software expansion for STM32Cube*
- *DB2613: Real-time activity-recognition software expansion for STM32Cube*
- *UM1724: STM32 Nucleo boards*

# 6 Revision history

**Table 5: Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 05-Aug-2015 | 1 | First release. |

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